

AR43

The Story of SUGAR



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SUGAR—a sweet crystalline substance, sucrose, cane sugar or beet sugar $C_{12}H_{22}O_{11}$, obtained chiefly from the juice of sugar cane or sugar beet...extensively used for food purposes...Sugar is a member of the carbohydrate family, supplying about 15 per cent of our *calorie intake.

FEB 1 1977

This is the definition for a commodity, the origin of which is shrouded in antiquity. Over the intervening centuries, sugar has become a significant ingredient in a balanced diet.

Since earliest times man has required sugar; and he discovered that although all plants make sugar, only sugar cane and sugar beets economically make enough to contribute to the vast fuel and energy requirements of an active world population.

Sugar is a natural food. Chlorophyll, the green colouring matter in plants, is the key to the natural production of sugar. The presence of soil, air, water and sunshine, combine to produce sugar.

The starch in the potato is the result of sugar synthesized in the leaf of the potato plant; starch in an ear of corn is dependent upon the sugar in the stalks. The opium of the poppy, the perfume of the rose and the beauty of its petals are derived from sugar through the alchemy of the plant. In fact, every organic compound in the plant comes from sugar.

Through the ages scientists have not been able to duplicate this simple, yet fascinating, process of nature. Also, while a thousand and one substitutes and synthetic imitations have emerged briefly, sugar has never been obtained in commercial quantities from anything but the sugar beet and the sugar cane.

Cane and beet sugar produced in Canada are identical in taste and composition. The quality of these products ranks among the highest in the world sugar industry.

* Calories are the units of measurement of the amounts of food energy we require to live, to work, to play.

FROM THE STONE AGE INTO THE 20TH CENTURY

While the precise origin of sugar is lost in the annals of history, there is evidence that Neolithic Man of the later Stone Age found enjoyable the sweetness he obtained from chewing certain plants.

Whether these plants resembled either of the two major sources of today's sugar...the sugar cane or the sugar beet...has not been established.



Sugar cane probably had its origin in the South Pacific around 8,000 years ago. The cultivation of the plant spread from New Guinea to Asia and India.

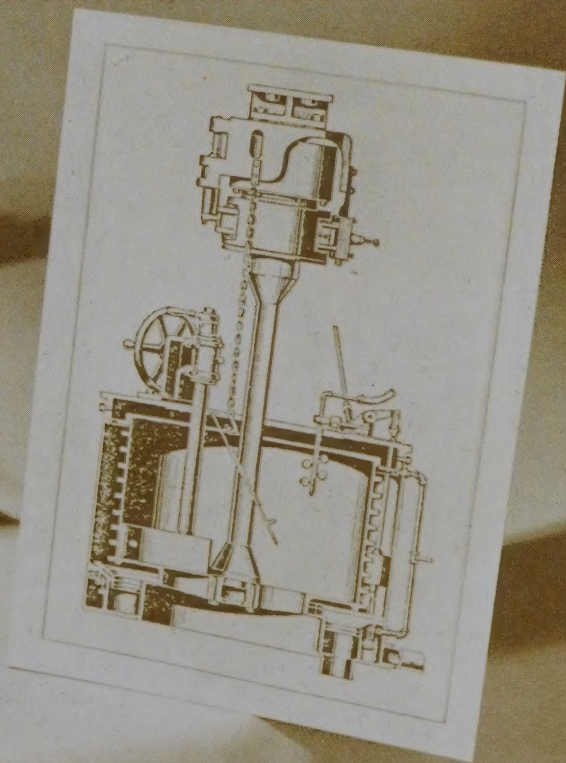
The first specific mention of "sugar" has been traced back to 325 B.C. and was made by an officer in the army of Alexander the Great invading India. It is believed that the substance had been known there for perhaps several centuries.

History also indicates that sugar cane cultivation and refining were present in China about 100 B.C.

It was more than seven centuries after sugar cane was being grown in China, that its cultivation commenced in the Mediterranean area of Europe.

Spaniards were responsible for sugar cane cultivation in the Canary Islands. On his second voyage in 1493, Christopher Columbus took cane to the Caribbean, and by 1550 sugar had become one of the most valuable products in Hispaniola (now Haiti and Dominican Republic).

So extensive had production become in Caribbean areas by the 1600's, refineries had been established in both England and France to refine raw sugar from the West Indies. It was only a matter of time before sugar cane was introduced to the southern United States.



Sugar Beets

Sugar beets also were known to the ancient world. Egyptians, long before the birth of Christ, used the roots of a vegetable—with an amazing resemblance to today's sugar beets—to obtain a sweet juice.

The evolution of beets as a commercial source of sugar, dates from the 1700's when a German scientist discovered sugar from the white beet was the same as sugar from cane. Development of a practical method for the extraction of sugar from the beets led to establishment of beet growing and beet processing, in Prussia, France, Austria and Russia.

Napoleon Bonaparte probably did more to establish sugar beets as a major source of sugar in Europe than anyone else. The blockade of Europe during the Napoleonic Wars cut off supplies of raw cane sugar from the West Indies. The development of beet sugar was the only alternative.

In 1840, on a worldwide basis, beet sugar accounted for about five per cent of global supply. Today it is 40 per cent of the total world output.



The growing of cane in Canada is impossible because of the climate. Raw cane sugar is imported from the tropics for refining in Canada. Cane sugar refining began in Montreal in 1854. A second refinery was built in Montreal in 1879, and this was followed by refineries in Vancouver (1890) and Saint John (1915). Since 1959 three new cane refineries have been built; one each in Toronto, Oshawa and Montreal.

Originally raw sugar was transported from the Caribbean to Canada in sailing barques, with six-foot draught. Nowadays raw sugar arrives at Canadian docks from as far away as the Indian Ocean or Australia, in cargoes of 10,000 to 30,000* tonnes.

Sugar beets are an annual crop adaptable to temperate countries. In the 1880's and 1890's three attempts were made to produce sugar beets and beet sugar in Quebec, but all of these ventures failed. Beginning in 1902, sugar beets were successfully grown in southwestern Ontario for 66 years. In 1903 sugar beets were started in southern Alberta, but the processing companies were in frequent financial difficulty until B.C. Sugar Refining Co. Ltd. acquired them in 1931.

In the 1950's there were seven beet sugar plants operating in four provinces. Three of these were closed in the 1960's, but today four thriving beet sugar plants exist, two in southern Alberta, one in Manitoba and one in the eastern townships of Quebec.

Today there are six competing companies and ten manufacturing units across Canada making refined cane and beet sugar. Roughly speaking Canada has one sugar manufacturing facility per two million people. Because of the density of the United States population, U.S. refiners enjoy larger and closer markets, and there is one U.S. manufacturing unit per three million Americans. As in most manufacturing enterprises, U.S. sugar processors therefore have advantages of scale, in competition with Canadians.

*Metric Tonne—1,000 kilograms or 2,204.6 lb.

FROM FIELD TO FOOD

In the process chart on pages 12 & 13, the sugar refining process for sugar beets and sugar cane is shown. The resultant product is refined white, liquid and invert sugar. At the beginning, the refining processes for beet and raw sugar are different, but become essentially the same from Point "X".

Sugar Cane

Sugar cane is a grass-like plant, resembling corn in appearance, that grows to a height of more than four metres in tropical climates. It needs 150 to 170 centimetres of water annually, and a constant temperature. The growing period is nine to 24 months.

Sugar cane is a perennial and the crop is cut each year for about five years before replanting. One acre of cane yields about 50 tonnes of vegetation and about five tonnes of raw sugar.

Sugar cane is stripped of its leaves either by hand or by setting the cane field on fire. The stalks are then cut and topped manually or mechanically. The cut cane is then transported to a sugar mill where various processes take place to produce "raw sugar".

Raw Sugar to Point "X"

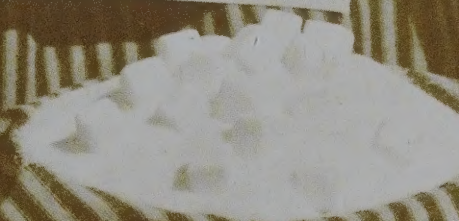
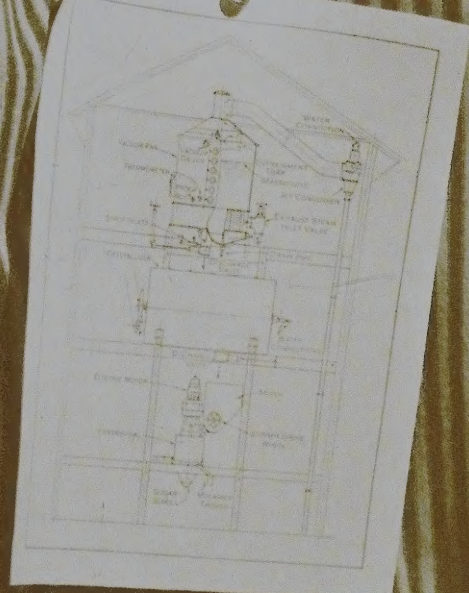
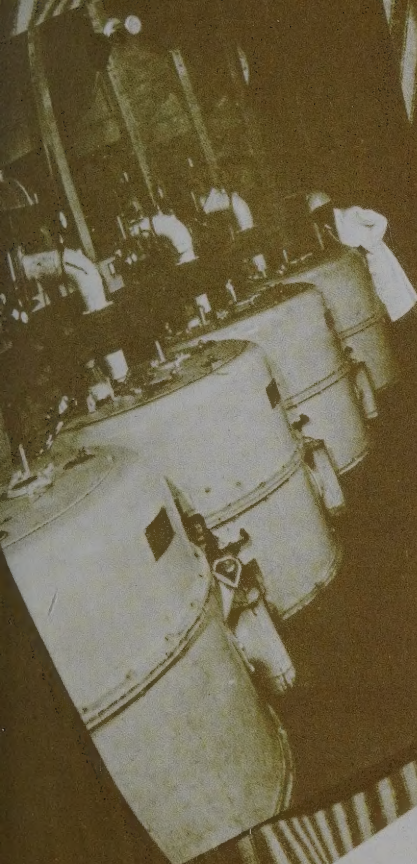
At the sugar mill, in the tropics, the sugar cane stalks are crushed to separate juice from the fibre. The juice is rolled through a series of presses to produce raw sugar of about 97 per cent purity.

The pressed, fibrous material or "bagasse" that is left, is used for fuel and in some instances to make paper and insulating board. The final syrup remaining, after the raw sugar process, is molasses.

The raw sugar is shipped in bulk in ocean-going freighters to Canadian sugar refineries for refining. Bulk cargoes have to be ordered three to eight months before the Canadian refinery plans to refine and market the product.

From the bulk raw sugar warehouse, raws are passed through a minger where syrup is added to soften the syrupy film adhering to the raw sugar crystals. The semi-liquid mass is then poured into large centrifuges. (The centrifuge is a device similar to the familiar spin drier in the family washing machine.) The centrifuge rotates at high speeds spinning off the syrup and associated syrupy film leaving crystals of raw sugar behind. Washed raw sugar crystals are conveyed to the melter where they are dissolved in hot water to produce a brownish sugar "liquor".

The "liquor" passes through tanks containing char which absorb colour from the liquid to make it crystal clear and water white. Sugar "liquor" is now at Point "X".



SUPERGRADE (California), the production of pure sugar from the cane is a process of great importance. It is a process which requires a great deal of skill and labor. The cane is first cut into stalks, and then the juice is extracted. The juice is then boiled and the sugar is crystallized. The sugar is then refined and the molasses is removed. The sugar is then packed in bags or barrels for export.



Sugar Beets

Sugar beets are annual plants that grow in the earth to a depth of about 25 to 40 centimetres and send down fibrous rootlets a metre or more.

Sugar beets are grown from seed and are planted annually, in rotation with other crops. Beets require large amounts of water during their six month growing season. The average sugar beet, similar in appearance to a large parsnip, weighs about one kilogram and contains up to 140 grams (35 teaspoons) of sugar. It bears no physical resemblance to the garden, red beet. One acre of beets yields 10 to 20 tonnes of vegetation and about one and three-quarters to three tonnes of sugar.

Beet growers and beet sugar processors in Canada negotiate shares in the returns from the sale of manufactured products. Currently western growers receive 63 per cent of the net receipts from sugar sales.

The sugar beets are lifted from the ground at harvest time. The bushy green tops are slashed off and sold as one of the best protein-rich cattle feeds available. The beets are then loaded onto trucks and taken to the sugar beet factory.

Sugar Beets to Point "X"

The sugar beets are harvested within three to four weeks and stored in piles at the factories. The beets are conveyed to a large washer and then sliced by a machine into thin strips about the size and shape of "shoe-string" potatoes. The strips are then sent into a large diffuser where the sugar is soaked out by hot water. The resultant juice is treated with lime and carbon dioxide to remove impurities. After filtration the juice is concentrated in evaporators, which boil off much of the water. The beet juice is now at Point "X".

The sugar beet slices, from which sugar has been removed, are treated with molasses, dried and pelleted, and marketed as a valuable livestock feed. Beet molasses, unlike cane molasses, is unsuitable for human consumption. However it is a valuable byproduct when used as an ingredient in cattle feed. It is also in demand as a material for fermentation, to produce citric and other organic acids, and for the manufacture of yeast.



Cane and Beet Sugar From Point "X"

From "X", sugar is fed to huge vacuum pans. Here further boiling takes place at low temperatures, under less than atmospheric pressure. This prevents caramelization and permits crystallization of sugar.

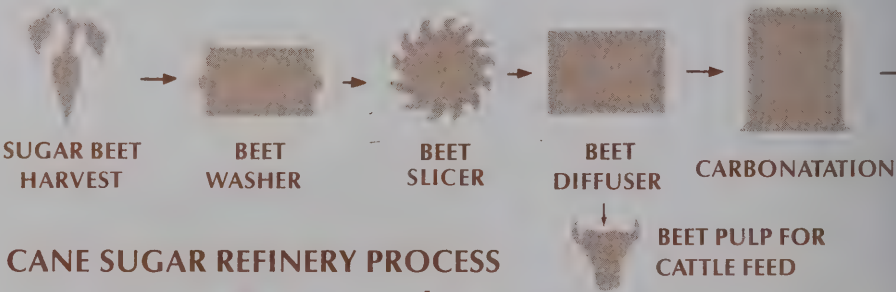
When operators see that the sugar crystals have grown to a required size, they allow the mass to flow to a series of refined sugar centrifuges.

The moist refined white sugar retained in the centrifuge baskets is then conveyed to a granulator or drier in which sugar rotates down a long drum through a current of hot air.

The sugar is then sent to large vibrating screens where it is separated into its various crystal sizes or "grades" such as coarse, fine or very-fine granulated sugar, prior to storage and packaging.

In the packaging operation sugar is packaged in bags varying in size from 40 kilograms to smaller packages for home use, and individual service envelopes for restaurants. Some of the sugar passes through a machine

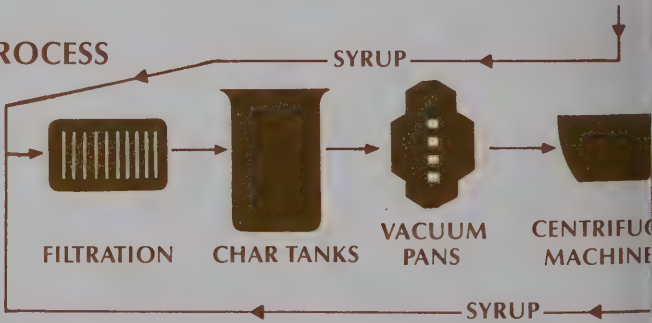
SUGAR BEET FACTORY PROCESS



CANE SUGAR REFINERY PROCESS



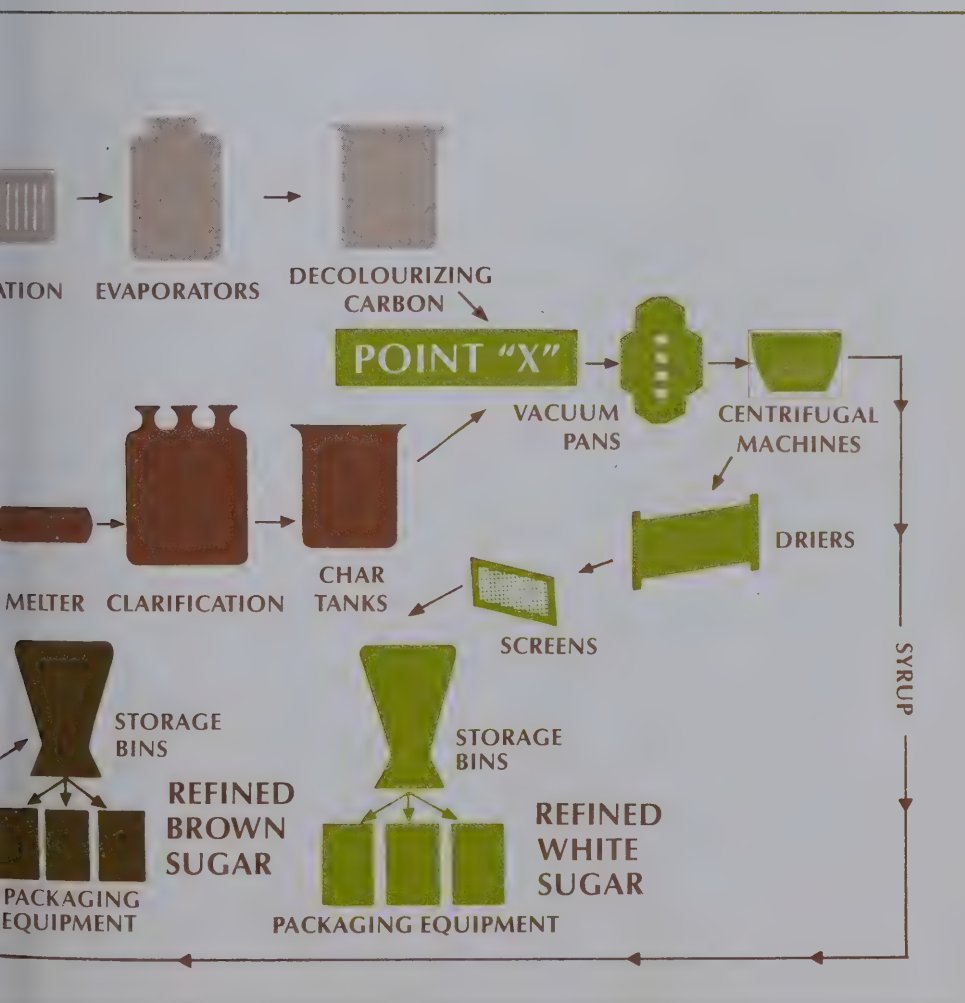
BROWN SUGAR PROCESS



that presses the moist sugar into cubes, and wraps and packages them; still other sugar is made into icing. The sugar refining process is completely mechanical and the sugar is never touched by machine operators' hands.

Brown and yellow sugars are produced only in cane sugar refineries in the following manner: when sugar syrup flows from the centrifuge machines, it passes through further filtration and purification stages and is reboiled in vacuum pans such as the two illustrated in the process chart. The sugar crystals are then centrifuged but not washed, so the sugar crystals still retain some of the syrup which gives the product its special flavour and colour.

During the whole refining process almost 100 scientific checks for quality control are made, while workers in research laboratories at the refineries maintain constant experiments, to improve the refining process and the final product.



SUGAR IN THE CANADIAN ECONOMY

In Alberta, Manitoba and Quebec, the beet sugar industry, in the years 1973-1974, provided an average cash income of \$40 million a year for some 2,500 farmers. In the cane refineries of Canada direct year-round employment was provided for another 2,700.

Values of imports of raw cane sugar fluctuate, but in a typical year Canadian cane refiners pay tropical sellers \$300 million for their raw material. This places purchasing power into the hands of nations which can buy Canadian goods. These imports have encouraged Canadian trade since before Confederation, when Canada exchanged fish products for West Indies sugar.

Nowadays after their primary outlets in United Kingdom and United States are served, the West Indies seldom produce sufficient raw sugar to supply Canada. Raw cane sugar sources for Canada now are: Natal, Australia, Cuba, Swaziland and Dominican Republic.

Canada favours multi-lateral trading arrangements, rather than special agreements with individual countries. This national policy has resulted in world-competitive sugar prices for Canadian consumers. Over the long term Canadian refined has been cheaper than in most other developed countries. There have been occasions when, because of global shortages, Canadians have been faced with extraordinarily high prices, as in 1920 and 1974, but these aberrations have been of short duration.

The Canadian sugar industry has contributed to efficient production of refined sugar at reasonable prices. The three largest cane sugar refiners operated on an after-tax profit of two-thirds of one cent per pound (1.5 cents per kilogram) in the years 1967-74 inclusive, and beet sugar manufacturers have competed with these cane sugar prices. All this has been achieved with effective import tariff protection for cane refiners, which has varied from less than zero to four-tenths of one cent per pound, (nine-tenths of a cent per kilogram) since 1970, depending on the origins of raw sugar and refined sugar imports.¹

Food experts around the world have become concerned about projected production of food for growing populations. The United Nations estimate demand for food will grow at the rate of 3.6 per cent per year in developing countries, 1.5 per cent in developed countries. More calories of food energy can be produced from an acre of sugar (beets or cane) than from any other crop. (See table on opposite page.)

¹Food Prices Review Board; Sugar Prices II: The Canadian Refining Industry; August 1975.

Refined Sugar Prices in Selected Developed Countries

Average 1969-1973	Cents Retail Per Kilogram
CANADA (MONTREAL)	27.9
Austria	27.7
Belgium	38.7
Denmark	35.4
Finland	40.7
France	30.6
Germany, Federal Republic	34.1
Netherlands	35.6
Sweden	36.7
Japan	44.2
United States	30.5

Source: International Sugar Organization, London except Farr Man, N.Y., for U.S.A. 1973

The Department of Agriculture in Washington has produced statistics indicating that more calories per acre can be produced from sugar, than from potatoes, cereals, eggs, chicken or beef. It takes six to eight times as much wheat land as sugar to produce a million calories. Because sugar is such an efficient source of calories per acre, agricultural planners recognize sugar as an important and renewable food resource.

Every ten years, the International Labour Office in Geneva records the minutes of work required for non-agricultural workers to buy one kilogram of sugar. The results show Canadians consistently have required less work per unit of sugar than citizens in other countries.

		Minutes of Work Required to Purchase One Kilogram of Sugar			
		Country	1952	1962	1972
		Austria		27	12
	Acres of	Belgium	27	19	12
	Land to	Denmark	10	12	7
	Produce	Finland	20	38	17
	1,000,000	France	62	29	17
	Calories	Germany, Federal Republic	49	22	10
		Netherlands	54	26	13
		Sweden	20	12	9
		United Kingdom	23	13	9
		Canada	11	6	6
		U.S.A.	8	7	5
		Japan	121	59	17
		Australia	15	13	9
Food Source					
Sugar	0.15				
Potatoes	0.44				
Corn (as corn meal)	0.44				
Wheat (as whole wheat flour)	0.90				
Wheat (as refined wheat flour)	1.20				
Hogs (pork and lard)	2.00				
Whole Milk	2.80				
Eggs	7.80				
Chickens	9.30				
Steers	17.00				

SUGAR CONSUMPTION

The amount of sugar eaten by the average Canadian has not been accurately determined. Statistics Canada presents figures on shipments within Canada, and imports, but these figures include: sugar used in products such as pet foods, explosives, tobacco and pharmaceuticals; sugar included in sweetened foods manufactured in Canada and then exported; overbuying in anticipation of rising prices; and sugar that has been wasted. There is a significant amount of sugar wasted by consumers.

The data available, representing "disappearance" of sugar, is bound to indicate more than actual consumption.

Annual Canadian consumption is estimated to average less than 45 kilograms per person, and is based on domestic refined production, plus imports, less exports of refined sugar. Of this maximum of 45 kg, about 27 kg are used by food manufacturers. Major Canadian products containing sugar are: soft drinks, canned and frozen fruits and vegetables, confectionery, baked goods, biscuits, dairy products, breakfast cereals and wines.

It is estimated that less than 18 kg per person per annum are used in the average home.

It is interesting to note that disappearance per person in Canada is about the same as it was 40 years ago, before and after World War II controls, and during the first two years of wartime rationing.

In 1971-1972 "disappearance" of sugar in several developed countries ranged from 43 to 60 kilograms per person annually.

Annual Sugar Disappearance Per Person

*Crop Year 1971-1972

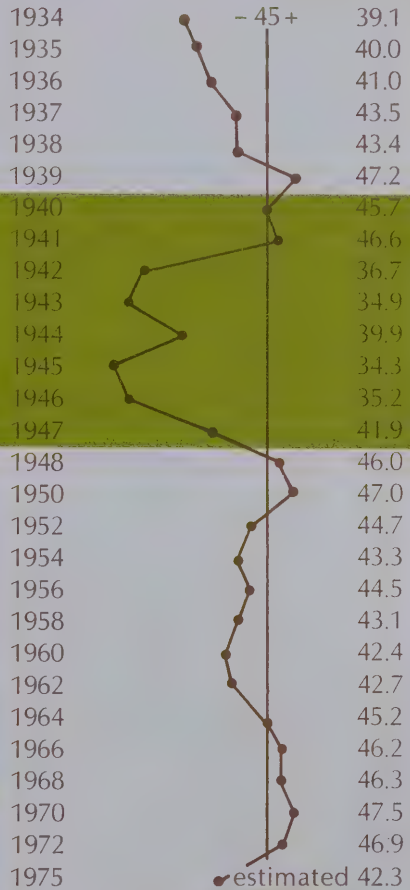
Country	Kilograms
Israel	60.1
Iceland	56.6
Australia	53.9
New Zealand	51.8
Denmark	50.0
Switzerland	47.0
U.S.A.	47.0
Canada	46.0
Bulgaria	45.3
Finland	44.9
Sweden	43.3

(Source: F.O. Licht; World Sugar Statistics, 1972-1973)

*Sept. 1 to Aug. 31

Domestic Disappearance of Refined Sugar in Canada

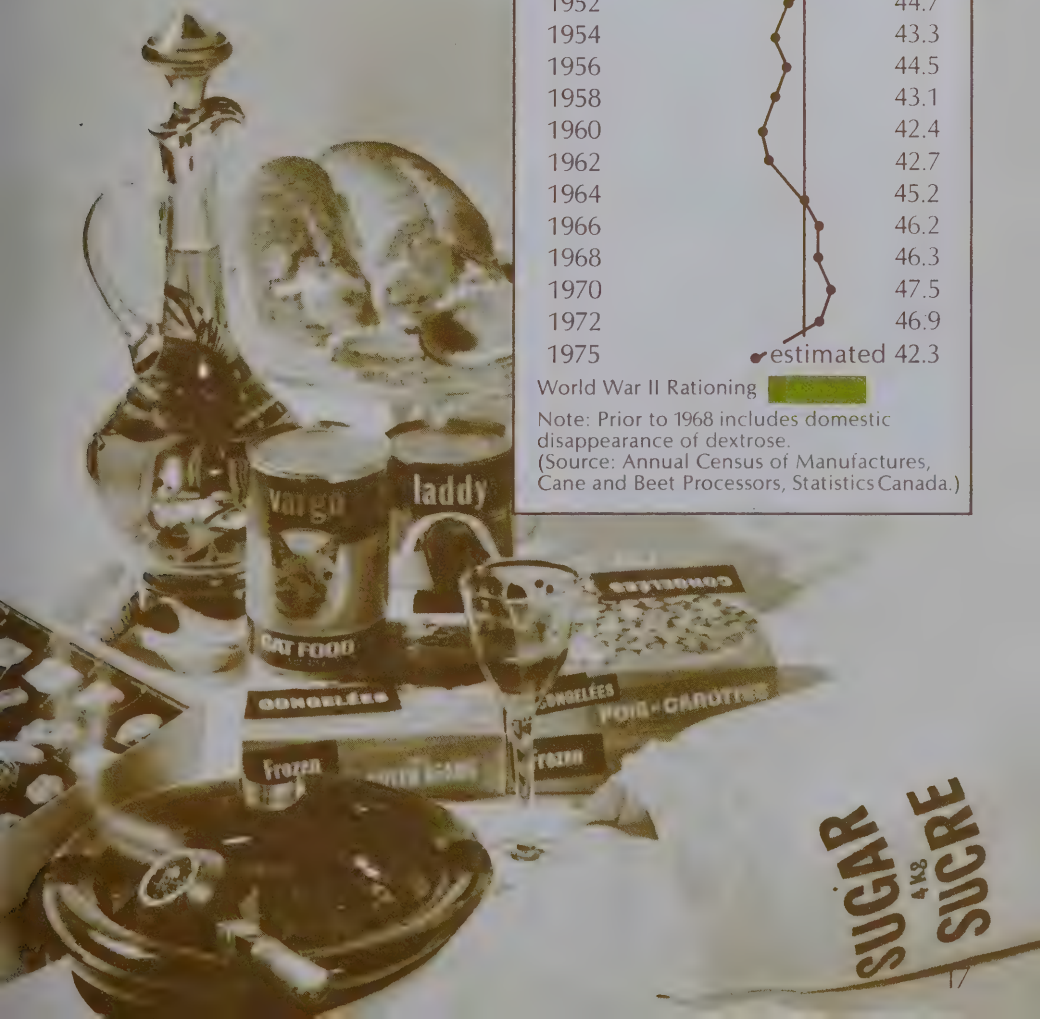
In Kilograms
Per Person, Per Year



World War II Rationing

Note: Prior to 1968 includes domestic disappearance of dextrose.

(Source: Annual Census of Manufactures, Cane and Beet Processors, Statistics Canada.)

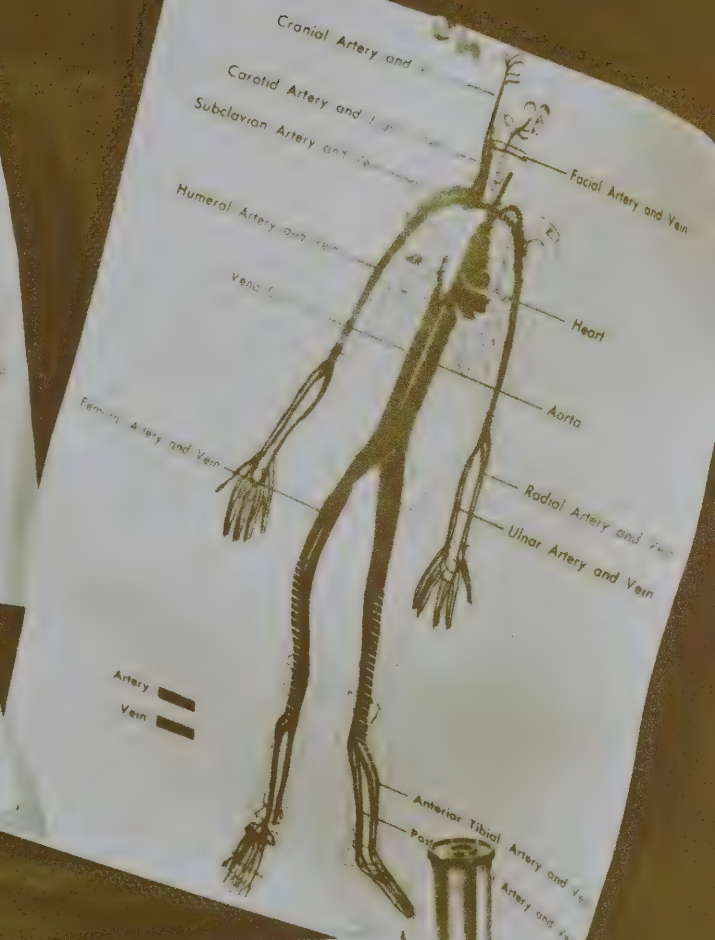
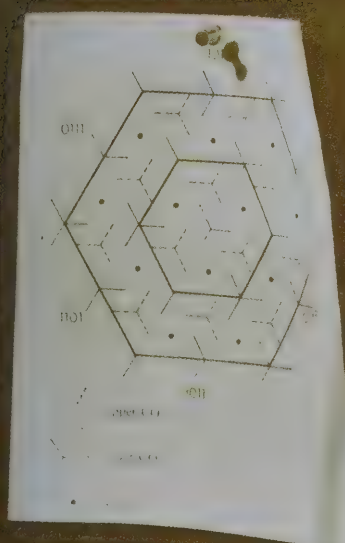


THE METABOLISM OF SUGAR

Almost all nutrients—carbohydrates, proteins, fats, vitamins (but not minerals)—contain some food energy. Sugar, however, is believed to provide body fuel more quickly than most other foods. Ingestion of sugar results in higher blood sugar levels within one to four minutes.

As it is eaten, sugar passes through the mouth without chemical change. In the digestive process, it is converted into equal parts of two simple carbohydrates—glucose (or dextrose) and fructose (or levulose)—which enter the bloodstream through the walls of the small intestine. The blood carries the glucose-dextrose, and their compounds, to the tissues where any excess is removed and stored as glycogen, a starch-like compound, or converted to and stored as fat.

When more glucose is needed in the body, the liver converts glycogen into glucose which is then delivered by the bloodstream to the muscle and other organs. Body cells break down this blood sugar into carbon dioxide and water, and energy is released. The carbon dioxide is carried by the blood to the lungs and is exhaled. The water is thrown off by the lungs, the kidneys and as perspiration.



SUGAR IN A BALANCED DIET

"Sugar, a pure carbohydrate, is an important nutrient and food in the...diet when used in moderation...Sugar is a digestible carbohydrate, and all digestible carbohydrates are nutrients..." These statements come from a symposium entitled "Sugar in the Diet of Man" reported by the World Review of Nutrition and Dietetics (Basel, 1975).

Sugar provides 15 calories per teaspoon (4 grams) or less than four calories per gram.¹ By comparison, fats supply about nine calories per gram.

There is no commonly accepted guide for the number of calories which should be consumed each day for energy. Much depends upon the individual and his or her activities.

According to the Committee for Revision of the Canadian Dietary Standard, the daily calorie requirement for the average male 16 to 18 years old, is 3,200; for the average female 2,100. Older people, on average, require fewer calories.²

On the assumption the average Canadian consumes 45 kg of sugar per year (a maximum figure) as one of the ingredients in the diet, it is estimated sugar supplies about 15 per cent of the daily requirement of calories for average 17-year-old males. This percentage undoubtedly varies among individuals depending on food selection patterns and on energy expenditures. It is estimated that in most developed countries, carbohydrate supplies 45 to 50 per cent of total daily calories.³ Therefore, on the average, sugar makes up about one-third of the total carbohydrates, the other principal carbohydrates being starches. It could be costly to find a substitute for sugar in a balanced diet.

A recent Nutrition Canada study on obesity in the adult population concluded the problem existed because some adults consumed too much food in relation to their activities, or did not get adequate exercise. There was an energy imbalance. The study said: "Calories alone do not account for the overweight problem. Those who are overweight and those who are not, do not differ greatly in the number of calories they consume. The main cause is likely to be a sedentary life and therefore both factors, caloric intake and physical activity need to be considered."⁴

¹Ministry of Health and Welfare, Canada; Table of Food Values Recommended for use in Canada; 1964.

²Food Prices Review Board; What Price Nutrition; February 1975; pp. 11.

³Statistical Abstract of the U.S.; Washington; Bureau of the Census; annual.

⁴A National Survey by Nutrition Canada; 1973; p. 112.

At a scientific discussion held in Stockholm, Dr. Arvid Wretling, former director of the Swedish Food and Drug Administration and currently Professor and Director of the Nutrition Unit, Carolina Institute, Stockholm, summed up as follows:⁵

"Good nutrition consists of adequate amounts of water, protein, fat, carbohydrates, minerals, vitamins and fibre. (Water is regarded as a nutrient since it is essential for life processes.) Such nutrition may be obtained by diets containing sugar which is a widely consumed, cheap carbohydrate...

"The amount of sugar in a given satisfactory diet should not be such that it dilutes the nutrient density of the total intake to an unacceptable level. The amount which is acceptable depends upon the nutritive quality of the other constituents of the diet, hence there is not a single figure that can be set as an acceptable level for all dietary patterns.

"Some of the participants (at the Stockholm conference) mentioned figures of 10 to 20 per cent of total energy of the diet as moderate amounts of sugar, with active persons using the larger percentage in this diet, less active using the smaller one. If the rest of the diet is such that adequate amounts of all nutrients are obtained, such levels are acceptable from a nutritional point of view."

People enjoy sugar. They like to eat foods that are sweetened. It is sugar that adds to grapefruit's palatability; that balances the flavour of salad dressings and soups; that increases the desirability of baked goods and dairy products, such as ice cream.⁶ Sugar is seldom used alone. It is eaten with other foods which contain specific nutrients, such as vitamins and minerals.

Used in moderation, as befits consumption of all foods and drink, so that other nutrients in a rounded diet are not excluded, sugar is destined to continue to play an important role in Canadian nutrition. It is no longer a luxury. Canadian refined sugar is a staple in the diet.

⁵World Review of Nutrition and Dietetics; vol. 22; pp. 237-326; Karger, Basel; 1975.

⁶Robinson, C. H.; Fundamentals of Normal Nutrition; New York; Macmillan Co., 1968.

SOME BASIC TYPES OF REFINED SUGAR

Canadian sugar refiners and manufacturers sell up to 80 different grades and packages of sugar. Some of the common ones are:

GRANULATED This refined sugar is the most common form used in households and commerce. It is produced in various crystal sizes and usually packaged in 1, 2, 4 and 10 kg containers for home use; in small individual service envelopes for restaurants and airlines; in 20 and 40 kg bags and in bulk for food manufacturers. Canadian Food and Drug Regulations require a minimum purity of 99.8 per cent sucrose, but all refined white sugar produced in Canada exceeds 99.9 per cent.

BULK GRANULATED Many food manufacturers purchase granulated in bulk form, to save handling and storage costs in their plants. It is delivered in specially-designed trucks or railway cars, which can carry 20 tonnes and 85 tonnes respectively.

LIQUID SUGAR This mixture of water and sugar is preferred by some food manufacturers. Liquid sugar is "metered" into the manufacturers' process. There are many grades and blends of liquid sugar tailored to suit food manufacturers' requirements.

INVERT SUGAR When water and sugar are heated in the presence of a weak acid solution (like in the stomach), the sucrose breaks up into sweeteners of simpler chemical structure: dextrose and levulose. The product, known as invert sugar, is slightly sweeter than sucrose and is popular with some industrial users like soft drink bottlers and confectioners.

ICING SUGAR Icing sugar is pulverized granulated sugar to which not more than five per cent of starch or other anti-caking ingredient is added.

BROWN SUGAR, YELLOW SUGAR Brown sugar, light brown sugar, yellow sugar are refined products, containing a molasses-flavoured syrup which gives the product a distinctive taste and colour. It is available in a variety of grades and colours, and is a "soft" sugar.

DEMARARA-STYLE SUGAR This is a dark brown sugar containing coarse crystals.

MOLASSES Molasses is a byproduct of the cane and beet refining processes. Cane sugar molasses is edible and comes in many grades from fancy (the highest grade) to blackstrap molasses. Sugar beet molasses is non-edible, but it is valuable in the marketplace for the manufacture of yeast, citric acid and for cattle feed mixtures.

RAW CANE SUGAR This product is imported into Canada in special bulk-cargo ships. Conditions under which it is manufactured and shipped vary. Raw sugar is not included in the Canadian Food Regulations because this product does not meet Canadian standards for health and hygiene.

CANADIAN SUGAR REFINING COMPANIES



Atlantic Sugar,
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Charlotte Street, Saint John, N.B.



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Vancouver, B.C.



Canadian Sugar Factories
306-10th Avenue South
Lethbridge, Alberta



Manitoba Sugar Company
555 Hervo Street
Winnipeg, Manitoba



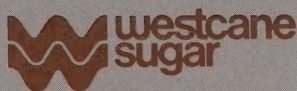
Cartier Sugar Ltd.
Notre Dame
Industrial Buildings Ltd.
300 Canal Bank Road
Ville St. Pierre
Montreal, P.Q.



Redpath Sugars Limited
1720 du Canal Street,
Montreal, P.Q.
and
95 Queen's Quay East
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Sucronel Limited
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